MATING DISRUPTION THROUGH BEHAVIOURAL MANIPULATION OF *SPODOPTERA LITURA* FABRICIUS

S. VENKATESWARA RAO, K. M. AZAM and KHALID AHMED
Regional Agricultural Research Station, Lam, Guntur 522 034, India

SPODOPTERA LITURA Fabricius is a polyphagous pest on 112 species of plants belonging to 44 families. In India 40 species of cultivated plants and 24 wild plants have been reported as hosts. It is a regular major pest and often causes severe damage to cotton, tobacco, chilli, groundnut, castor, pulse crops, tomato, brinjal, cabbage, cauliflower, bhendi, sweet potato, banana and minor spice crops. Severe outbreaks of the pest were reported in cotton-growing tracts of the country in the past ten years.

Excessive dependence on insecticides against the pest leads to large-scale destruction of its natural enemies in the environment. The pest also defies the normal control interventions as it has developed resistance to DDT, BHC, endosulfan, carbaryl. malathion, fenitrothion, methylparathion and monocrotophos, and to *Bacillus thuringiensis* B[1-4]. Hence there is imminent need to develop and promote an ecologically suitable and environmentally compatible pest management strategy to tackle the pest effectively, and ultimately to prevent economic losses in crop production. Mating disruption through behavioural manipulation with the use of synthetic sex pheromones in an indigenous method using locally fabricated material has been investigated with a view to develop a viable strategy for the management of the pest.

Hollow fibres, plastic laminates and microcapsules were developed and used in mating disruption studies against *S. littoralis*, a close ally of *S. litura*. elsewhere. Efforts to obtain samples of these formulations for testing were not successful. This study was therefore designed and implemented using locally fabricated polythene vials as dispensers. The study was conducted on cultivators' holdings from the first week of December to the end of February for two successive years during 1984–85 and 1985–86.

Sixteen vials were impregnated with 1 g of the synthetic pheromone containing component 'A' (*Z, E*)-9,11-tetradecadienyl-1-ol acetate, and component 'B' (*Z,E*)-9 12-tetradecadienyl-1-ol acetate, in 10:1 ratio. Each vial was thus loaded with 6.25 mg of the pheromone. These 16 pheromone dispensers were set up equidistantly in a 0.4 ha chilli plot in two rows of 10 in the outer and 6 in the inner ring by hanging them from bamboo poles in such a way that the dispensers were 20 cm above the crop canopy. For comparison a control 0.4 ha plot of chilli crop was selected 1 km away from the experimental plot. At the central point of each plot a normal pheromone trap with a 2.5 mg pheromone dispenser and a dry polythene sleeve was set up as indicator trap to observe and record daily capture of *S. litura* male moths. The number of male moths trapped every day in the indicator traps and the number of egg masses laid were recorded to measure the impact of the pheromone on male orientation and mating disruption. The data obtained were subjected to *t* test for statistical significance.

Moth catches in indicator traps were very low in the experimental plot compared to the plot free from pheromonal influence in both years of the study (table 1). In the daily recording of the 13-week study, moths were not captured except on a few days (1 to 3 moths/trap/week) in the experimental plot. In the control, pheromone-free plots the moth catches were appreciably high, ranging from 5 to 115 and 11 to 6283 moths/trap/week during the first and second years of study respectively. The difference was significant, between experimental and control plots indicating the influence and impact of the pheromone permeated in the area on the orientation of male moths. Pest incidence in general was low during 1984–85; nevertheless both the seasons of the study showed identical trends. Field records of numbers egg masses also indicated sex disruption (table 1).

Campion[5] suggested the use of hollow fibres, plastic laminates and microcapsules for pheromone-mediated mating disruption in *S. littoralis*. In the present study the objective of permeating 1 g of pheromone in a 0.4 ha crop area was achieved with the use of locally available polythene vials set up at release points stationed at close spacing. Communication between male and female *S. litura* moths was effectively disrupted with this technique, which is thus an equally effective alternative to the slow-releasing imported formulations.

Assessment of the effectiveness of the pheromone and release method was based on the size of trap catches and egg mass counts, as has been done for *S. littoralis*[6,7]. But Oyama[8] and Kobayashi *et al.*[9] have used tethered virgin females to provide a direct measure of mating levels in their studies with *S. litura*. They recommended the use of at least 15 traps ha to achieve marked reduction in mating rate of teth-

Table 1 *Catches of S. litura male moths and number of egg masses in pheromone-exposed and unexposed chilli plots*

Standard week	Unexposed plot		Pheromone-exposed plot	
	Mean no. of moths	Mean no. of egg masses	Mean no. of moths	Mean no. of egg masses
1984–85				
45	12 (4.46)	4 (3.00)	0 (1.00)	1 (2.00)
46	48 (7.92)	5 (3.23)	0 (1.00)	0 (1.00)
47	115 (11.72)	15 (4.87)	0 (2.41)	0 (1.00)
48	46 (7.78)	23 (5.79)	2 (1.00)	0 (1.00)
49	23 (5.79)	15 (4.87)	0 (1.00)	1 (2.00)
50	26 (6.09)	10 (4.16)	0 (2.00)	0 (1.00)
51	16 (5.00)	9 (4.00)	1 (2.41)	0 (1.00)
52	14 (4.74)	4 (3.00)	2 (1.00)	0 (1.00)
1	75 (9.66)	3 (2.73)	0 (1.00)	0 (1.00)
2	13 (4.60)	5 (3.23)	0 (1.00)	0 (1.00)
3	5 (3.33)	1 (2.00)	0 (1.00)	0 (1.00)
4	27 (6.19)	2 (2.41)	0 (1.00)	0 (1.00)
5	16 (5.00)	1 (2.00)	0 (1.00)	0 (1.00)
t	2.70*	22.19	2.70**	22.19**
1985–86				
45	293 (18.11)	30 (6.47)	0 (1.00)	4 (3.00)
46	238 (16.42)	180 (14.41)	2 (2.41)	5 (3.23)
47	211 (15.52)	195 (14.96)	1 (2.00)	0 (1.00)
48	47 (7.85)	108 (11.39)	0 (1.00)	0 (1.00)
49	460 (22.44)	10 (4.16)	0 (1.00)	0 (1.00)
50	379 (20.46)	261 (17.15)	3 (2.73)	0 (1.00)
51	6283 (30.26)	350 (19.70)	0 (1.00)	0 (1.00)
52	20 (5.47)	2562 (51.61)	1 (2.00)	4 (3.00)
1	1310 (37.19)	41 (7.40)	2 (2.41)	0 (1.00)
2	756 (28.49)	1060 (33.55)	1 (2.00)	1 (2.00)
3	295 (18.17)	365 (20.10)	0 (1.00)	0 (1.00)
4	68 (9.24)	140 (12.83)	2 (2.41)	1 (1.00)
5	11 (4.31)	18 (5.24)	0 (0.00)	1 (2.41)
t	3.50**	3.11**	3.50**	3.11**

Figures in parentheses are the $\sqrt{x+1}$ transformed values.

females. Kawasaki and Miyashita[10] achieved 50% mating suppression with a field application of 72 mg pheromone per 0.4 ha. Kehat *et al.*[11], Hall *et al.*[12] and Campion[5] achieved mating disruption in *S. littoralis* with Hercone dispensers at 1.5 g/0.4 ha, and with microcapsules at 5 to 10 g/ha and 100 g a.i./ha, as against 1 g pheromone used per 0.4 ha in the present study. The present results agree with those obtained by Mitchel and McLanghlin[13] with hollow fibres for *S. frugiperda*, and by Campion *et al.*[14] for *S. littoralis*.

27 June 1988

1. Govindarajan, R., Jayaraj, S. and Narayana, K., *Indian J. Exp. Biol.*, 1975, **13**, 548.
2. Ramakrishnan, N., Saxena, V. S. and Dhinga, S., *Pesticides*, 1984, **18**, 23, 27.
3. Rote, N. B., Patel, B. K. and Mehta, N. P., *Andhra Agric. J.*, 1980, **27**, 104.
4. Reddy, C. N. V. S. and Reddy, G. P. V., *Andhra Agric. J.*, 1984, **31**, 85.
5. Campion, D. G., *Crop Prod.*, 1983, **2**, 3.
6. Hosney, M. M. *et al.*, *British Crop Protection Conference, Pest and Diseases*, 1979, vol. 2, pp. 395.
7. Campion, D. G. *et al.*, *Report*, Centre for Overseas Pest Research, London, COPR, 1980, pp. 130.
8. Oyama, M., *Appl. Entomol. Zool.*, 1977, **12**, 281.
9. Kobayashi, M., Wada, T. and Inove, H., *Symposium on IPM*, Isukuba, Japan, Sept. 1981, p. 32.

10. Kawasaki, N. K. and Miyashita, K., *Appl. Entomol. Zool.*, 1976, **11**, 320.
11. Kehat, M., Dunkelblum, E. and Gothilf, S., *Environ. Entomol.*, 1983, **12**, 1265.
12. Hall, D. R., Nesbitt, B. F., Marrs, G. J., Green, A. St. J., Campion, D. G. and Critchley, B. R., *Symposium on Chemistry and Applications of Insect Pheromone Technology*, American Chemical Society Symposium, August, 1981.
13. Mitchel, Z. R. and McLanghlin, J. R., *J. Econ. Entomol.*, 1982, 75, 270.
14. Campion, D. G. *et al.*, *Bull. Entomol. Res.*, 1976, **56**, 335.

Table 1 *Effects of cyanate and aspirin on blood pH, and urea, reduced glutathione (GSH) and ascorbic acid levels in blood and eye lens of rat*

	Blood		Lens	
	pH	Urea (mg/100 mg)	GSH (μg/g)	Ascorbic acid (μg/100 mg wet wt)
Control ($n=12$)	7.4 ± 0.1	9.24 ± 1.32	1.40 ± 0.11	4.24 ± 0.24
Cyanate-treated (12)	7.1 ± 0.1	14.01 ± 1.42	1.06 ± 0.10	2.65 ± 0.19
Cyanate-treated, fed aspirin (12)	7.3 ± 0.1	10.6 ± 1.18	1.28 ± 0.12	3.62 ± 0.25

BENEFICIAL EFFECTS OF ASPIRIN IN CYANATE-INDUCED HYPERCALCEMIA AND HYPERPHOSPHATEMIA IN RAT EYE LENS

V. K. SRIVASTAVA and N. CHATURVEDI
Department of Chemistry, University of Gorakhpur, Gorakhpur 273 009, India

CYANATE reacts with lens protein and induces conformational changes[1]. Bendazac was found to decrease binding of cyanate to lens proteins and prevent cyanate-induced elevation of phase separation temperature in incubated rat lens[2]. Exposure to cyanate has been considered as an important risk factor in cataract formation in India[3] and England[4].

Investigations were carried out on the effect of cyanate and aspirin on the metabolism of calcium and phosphate in lens and serum of rat. These studies are of significance as both calcium and phosphate play key roles in a wide spectrum of biological processes including the formation of cataract.

Male albino rats were divided into two groups. Twenty-four rats of group I (control) were intraperitoneally injected with 0.1 ml Ringer's buffer solution, pH 8.2. Rats of group II (48) were injected with 0.1 ml cyanate (5 mg) dissolved in Ringer's buffer, pH 8.2. Twenty-four rats of group II were orally given 0.2 ml aspirin (9 mg in 60% alcohol) per day. All animals were sacrificed after 30 days and calcium (Ca^{2+}) and phosphate (HPO_4^{2-}) levels in blood and lens were determined by atomic absorption and spectrophotometric[5] methods respectively.

Table 1 shows that the blood urea level increased by about 52% in rats injected with cyanate. Feeding aspirin to cyanate-treated rats inhibited the increase in blood urea. The increased urea level in the cyanate-treated rats resulted in decrease of pH from 7.4 to 7.1. Reduced glutathione (GSH) and ascorbic acid levels in lens also decreased. Aspirin inhibited the decrease. The levels of calcium and phosphate in plasma increased by 45 and 10.6% respectively (table 2). Interestingly, the increase in plasma resulted in an increase in calcium and phosphate levels in lens by 53 and 33% respectively. The results also show that aspirin feeding produced significant inhibition of increase in calcium and phosphate levels, with complete inhibition in the case of lens.

These studies show that cyanate induces uraemia and acidosis in blood, which are considered to be amongst the relevant factors involved in the processes leading towards development of diarrhoeal cataract[6]. The significant decrease in lens GSH and ascorbic acid is in agreement with earlier findings that their concentration decreased in almost all experimental cataracts and in human senile cataracts[7]. The cyanate-induced hypercalcemia and hyperphosphatemia in the lens also confirm results reported earlier[8]. The presence of aspirin possibly minimizes the charges on proteins and protein–water interaction, and thus prevents changes in the lens. The potential effect of aspirin on the lens depends on its concentration after systemic administration.

The authors are grateful to DST, New Delhi, for financial assistance. Thanks are due to Prof. J. J. Harding, University of Oxford, for a gift sample of cyanate.